



P25 DIGITAL VHF TRANSMITTER INSTRUCTION MANUAL

VT-4D 136-174 MHZ

Covers Models:

VT-4D140-R0-000

VT-4D160-R0-000

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IM21-VT3150AMP

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The user's authority to operate this equipment could be revoked through any changes or modifications not expressly approved by Daniels Electronics Ltd.

The design of this equipment is subject to change due to continuous development. This equipment may incorporate minor changes in detail from the information contained in this manual.

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GENERAL INFORMATION

Manual Organization

The organization of this document reflects the modular construction of the VT-4D family of products. Each product is fully described within its respective “sub-manual”; all of which are contained within this document. In general, each of these sub-manuals contain:

1. A functional description and specification summary.
2. A detailed technical description (Theory of Operation).
3. Assembly, setup and alignment procedures relevant to the particular module.

The following sub-manual is contained within this modular manual.

VHF Amplifier Instruction Manual: This manual provides information on alignment and operation of the 2 and 8 Watt RF amplifier modules.

The following manual is also required for alignment of the VT-4D family transmitter.

Radio Service Software Manual: This manual provides instructions on using the PC-based Radio Service Software package to perform Transmitter alignment and frequency and mode selection. This manual is available as a PDF file on CD that is supplied in the Radio Service Software and Interface Kit.

VT-4D150 Transmitter Family Models

There are four distinct models in the VT-4D150 Transmitter family each with different bands of operation and power outputs. The four models are as follows:

• VT-4D140-2	136-150 MHz band, 0.5-2.0 Watt
• VT-4D140-8	136-150 MHz band, 2.0-8.0 Watt
• VT-4D160-2	150-174 MHz band, 0.5-2.0 Watt
• VT-4D160-8	150-174 MHz band, 2.0-8.0 Watt

The transmitters' band of operation is determined by select components in the amplifier.

Performance Specifications

General

The following is a general set of specifications for the generic VT-4D150 transmitter. Additional specifications, specific to individual modules may be found in their respective sub manuals.

Type:	MT-4D Series Transmitter.
Family:	VT-4D150 136 - 174 MHz.
Compatibility:	MT-2, MT-3 and MT-4 Series Radio Systems, P25 interoperable.
Frequency Range:	136 to 150 MHz., 150 to 174 MHz
RF Power Output:	0.5 to 2.0 or 2.0 to 8.0 W Continuous.
Modulation:	Analog: 11K0F3E or 16K0F3E (Frequency Modulation). Project 25: 8K10F1E
System Impedance:	50 Ω ; Type N connector.
Duty Cycle:	100%; Continuous operation from -30°C to +60°C.
Emissions:	-70 dBc
Transmitter Mismatch Protection:	20:1 VSWR at all phase angles.
Operating Temperature Range:	-30°C to +60°C.
Operating Humidity:	95% RH (non-condensing) at +25°C.
Operating Voltage:	+13.8 Vdc Nominal (range +10 to +17 Vdc), +9.5 Vdc Regulated.
Transmit Current:	1.7 Amps at 2 Watts RF Power Output, 2.8 Amps at 8 Watts RF Power Output
Front Panel Controls:	NORM (repeat mode), OFF, and KEY TX (Tx on). MIC MODE: ANALOG and DIGITAL.

PTT Activation:	<ul style="list-style-type: none"> • Active to ground; Microphone activated; • Front Panel switch: KEY TX
PTT Time-Out-Timer:	Programmable from 1 sec. to 8 hrs or infinity. (Default 5 min.), using Radio Service Software package.
Standby Current:	
Transmitter with no encryption modules installed	Standby ≤ 75 mA
Transmitter with encryption modules installed	Standby ≤ 105 mA
DOC Type Approval:	TBA
FCC Type Acceptance:	TBA

Audio Specifications

Audio Input:	Balanced, 600 Ω or optional unbalanced input (600 Ω or 15000 Ω selectable input impedance)
Audio Response:	Pre-emphasis (6 dB per octave); +1 to -3 dB from 300 Hz to 3 kHz
Audio Deviation Limiting:	+/- 2.5 kHz, +/- 5.0 kHz
Audio Distortion:	< 3% THD; 1 kHz tone at 1.5 kHz or 3 kHz deviation
Hum and Noise:	-34 dB typical

Physical Specifications

Physical Dimensions:	Width:	Height:	Depth:
	7.1 cm (2.8 in)	12.8 cm (5.05 in)	19 cm (7.5 in)
Module Weight:	1.4 kg (3.0 lbs.)		
Corrosion Prevention:	Anodized aluminum construction. Stainless steel hardware. Gold plated module connectors.		
Module Design:	Compact Eurostandard modular design. Plug-in modules mate with Daniels standard M3 repeater subrack. Subracks/modules comply with IEEE 1101, DIN 41494 and IEC 297-3 (mechanical size / modular arrangement).		
External Connections:	RF Connection: type N connector located on the transmitter module front panel. Motherboard Connections (Audio, Power, and Control) are made through a 48 pin, gold plated, type F connector on the rear of the transmitter module. User connection made through mated "mother board" assembly of the repeater subrack. Type F standard connector complies with DIN 41612 Level 2 (200 mating cycles, 4 day 10 ppm SO ₂ gas test with no functional impairment and no change in contact resistance). Digital I/O: 8-pin RJ-45		
Handle Text Colour:	Red		



THEORY OF OPERATION



TRANSMITTER ASSEMBLY AND ADJUSTMENT

Repair Note

The transmitter is mainly made up of surface mount devices, which should not be removed or replaced using an ordinary soldering iron. Removal and replacement of surface mount components should be performed only with specifically designed surface mount rework and repair stations complete with ElectroStatic Discharge (ESD) protection.

When removing Surface Mount Solder Jumpers, it is recommended to use solder braid in place of manual vacuum type desoldering tools. This will help prevent damage to the circuit boards.



REPEATER SYSTEM CONFIGURATION



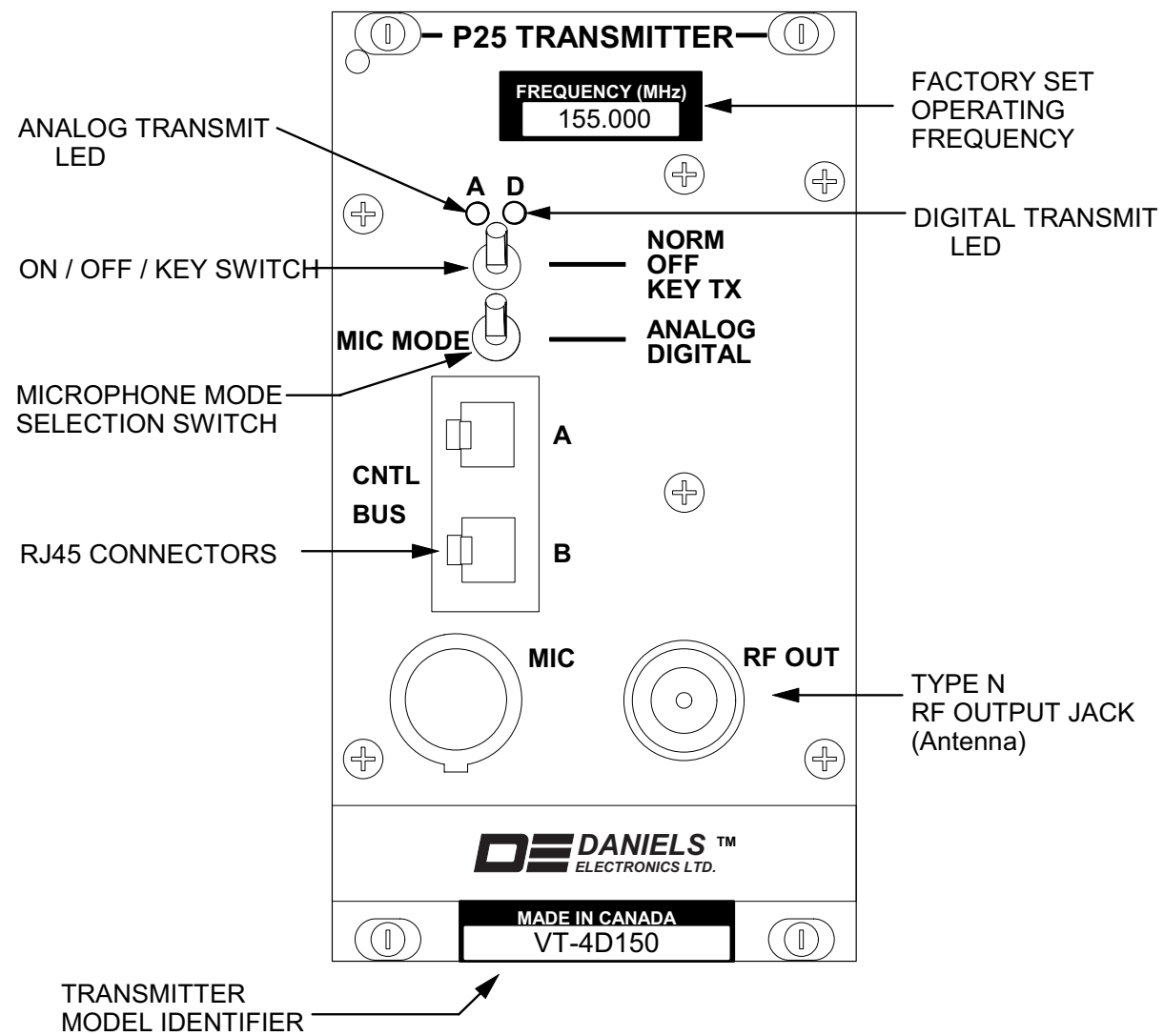
ILLUSTRATIONS AND SCHEMATICS

Printed Circuit Board Numbering Convention

Daniels Electronics Ltd. has adopted a printed circuit board (PCB) numbering convention in which the last two digits of the circuit board number represent the circuit board version. All PCB's manufactured by Daniels Electronics Ltd. are identified by one of the following numbering conventions:

PCB number	<u>43-912010</u> Indicates circuit board version 1.0
PCB number	<u>50002-02</u> Indicates circuit board version 2 (no decimal version)

P25 Digital Transmitter Front Panel



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DATE: 23 JUL 2003										DRAWN BY: Bryan Harper																																							
DWG No: B0297										REV DATE: -																																							



PARTS LISTS

P25 Digital Transmitter Electrical Parts List

Ref Desig	Description	Part Number
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REVISION HISTORY

Revision	Date	ECO	Description
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VHF TRANSMITTER AMPLIFIER INSTRUCTION MANUAL

VT-3 & VT-4 (132-174 MHz)

Covers Models:

A21-VPA145-08

A21-VPA165-08

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RF Exposure Warning

Exposure to radio frequency (RF) energy has been identified as a potential environmental factor that must be considered before a radio transmitter can be authorized or licensed. The FCC has therefore developed maximum permissible exposure (MPE) limits for field strength and power density, listed in FCC 47 CFR § 1.1310. The FCC has furthermore determined that determination of compliance with these exposure limits, and preparation of an Environmental Assessment (EA) if the limits are exceeded, is necessary only for facilities, operations and transmitters that fall into certain risk categories, listed in FCC 47 CFR § 1.1307 (b), Table 1. All other facilities, operations and transmitters are categorically excluded from making such studies or preparing an EA, except as indicated in FCC 47 CFR §§ 1.1307 (c) and (d).

Revised FCC OET Bulletin 65 (Edition 97-01) provides assistance in determining whether a proposed or existing transmitting facility, operation or device complies with RF exposure limits. In accordance with OET Bulletin 65 and FCC 47 CFR § 1.1307 (b), this Daniels Electronics Ltd. transmitter is categorically excluded from routine evaluation or preparing an EA for RF emissions and this exclusion is sufficient basis for assuming compliance with FCC MPE limits. This exclusion is subject to the limits specified in FCC 47 CFR §§ 1.1307 (b) and 1.1310. Daniels Electronics Ltd. has no reason to believe that this excluded transmitter encompasses exceptional characteristics that could cause non-compliance.

- Notes:**
- The FCC's exposure guidelines constitute exposure limits, not emission limits. They are relevant to locations that are accessible to workers or members of the public. Such access can be restricted or controlled by appropriate means (i.e. fences, warning signs, etc.).
 - The FCC's limits apply cumulatively to all sources of RF emissions affecting a given site. Sites exceeding these limits are subject to an EA and must provide test reports indicating compliance.

RF Safety Guidelines and Information

Base and Repeater radio transmitters are designed to generate and radiate RF energy by means of an external antenna, typically mounted at a significant height above ground to provide adequate signal coverage. The following antenna installation guidelines are extracted from Appendix A to OET Bulletin 65 and must be adhered to in order to ensure RF exposure compliance:

Non-building-mounted Antennas:

Height above ground level to lowest point of antenna ≥ 10 m or
Power ≤ 1000 W ERP (1640 W EIRP)

Building-mounted Antennas:

Power ≤ 1000 W ERP (1640 W EIRP)

The following RF Safety Guidelines should be observed when working in or around transmitter sites:

- Do not work on or around any transmitting antenna while RF power is applied.
- Before working on an antenna, disable the appropriate transmitter and ensure a "DO NOT USE" or similar sign is placed on or near the PTT or key-up control.
- Assume all antennas are active unless specifically indicated otherwise.
- Never operate a transmitter with the cover removed.
- Ensure all personnel entering a transmitter site have electromagnetic energy awareness training.

For more information on RF energy exposure and compliance, please refer to the following:

- [1] FCC Code of Regulations; 47 CFR §§ 1.1307 and 1.1310.
[2] FCC OET Bulletin 65, Edition 97-01, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields".
[3] <http://www.fcc.gov/oet/rfsafety/>

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GENERAL INFORMATION

Introduction

The VHF Transmitter Amplifier provides the final stage of RF amplification and filtering for the entire VHF Transmitter VT-3 132 - 174 MHz family and the VT-4 P25 Digital VHF Transmitters. The amplifier has two distinct frequency ranges: 132 to 150 MHz, and 150 to 174 MHz with continuously adjustable 2.0 to 8.0 Watts output power. This Amplifier is housed in a machined aluminum case that ensures optimum RF shielding, provides a good ground, and also acts as a heatsink.

Additionally, the VHF Transmitter Amplifier is equipped with output power and VSWR sensing lines that can be individually configured as open collector or linear outputs. The internal VSWR sensor protects the amplifier from high antenna VSWR by approximately halving the amplifier's RF gain when a VSWR overload condition is present.

The Lowpass Filter Board provides output filtering for the VHF Transmitter Amplifier. The Lowpass filter assembly is mounted in a separate compartment of the amplifier case in order to provided maximum attenuation of harmonic and other spurious signals.

Performance Specifications

Type:	VHF Transmitter Amplifier module for VT-3/150 , VT-4R and VT-4B series transmitters.
Compatibility:	MT-3 series FM Transmitter Main Board or MT-4 P25 Digital Transmitter Main Board.
Frequency Range:	132-150 MHz or 150-174 MHz.
RF Power Output:	adjustable 2.0 to 8.0 Watts
RF power Input:	nominal level adjustable from 0 dBm to +5 dBm, held within +/- 2 dB of nominal.
Output Impedance and VSWR:	50 Ω , Type N connector; 3:1 max. VSWR.
Input /Output Isolation:	> 60 dB
Duty Cycle:	100%: Continuous operation from -40° C to +60° C.
Harmonic Emissions:	< -90 dB _C .
Transmitter Mismatch Protection:	20:1 VSWR at all phase angles.
Transmitter Alarm:	Forward power sense and reverse VSWR; - open collector output (separate or 'OR'ed configuration); - linear output (separate lines only).
Operating Temperature Range:	-30° C to +60° C, optional -40° C temperature test.
Operating Humidity:	95% RH (non-condensing) at +25° C.
Operating Voltage:	+13.8 Vdc Nominal (range +11 to +16 Vdc), +9.5 Vdc Regulated.
Amplifier Standby Current:	< 0.5 mA.
Amplifier Enable:	Active to ground.
Amplifier Enable Response:	typically overdamped, rising to within 90% of full power within 5 msec; maximum (underdamped) overshoot of 30%.



THEORY OF OPERATION



VHF TRANSMITTER AMPLIFIER ALIGNMENT

Repair Note

The VHF Transmitter Amplifier is mainly made up of surface mount devices that should not be removed or replaced using an ordinary soldering iron. Removal and replacement of surface mount components should be performed only with specifically designed surface mount rework and repair stations complete with Electrostatic Dissipative (ESD) protection.

When removing Surface Mount Solder Jumpers, it is recommended to use solder braid in place of manual vacuum type desoldering tools. This will help prevent damage to the circuit boards.



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PARTS LISTS

VHF Transmitter Amplifier Electrical Parts List

Ref Desig	Description	Part Number
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REVISION HISTORY

Revision	Date	ECO	Description
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